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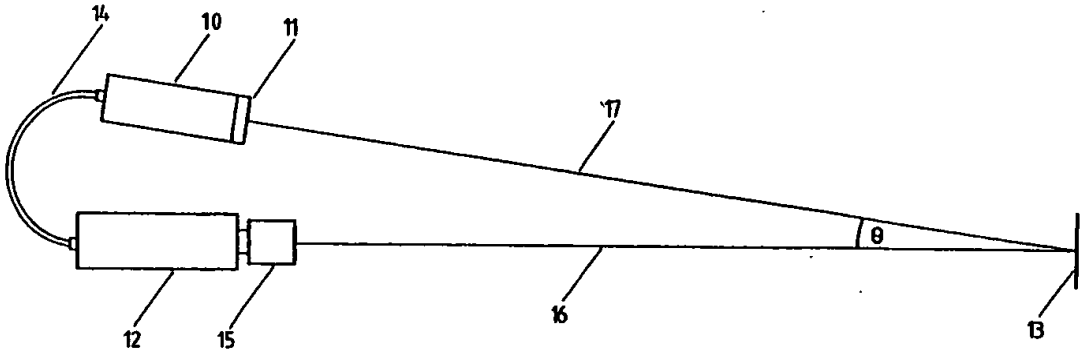

(57) Abstract

A surveillance apparatus, particularly for viewing vehicle number plates in covert, night operations, comprises an illuminator (10) having an array of light-emitting diodes (11) or a source of laser light, and a shuttered, preferably-miniature TV camera. The illuminator emits a series of high-peak pulses of infrared light (17) outside the range visible to the human eye, which reflect from a number plate (13) to be received by the camera which operates in synchronism with the illuminator. It is preferred to have the illuminator (10) positioned close to the camera lens (15) to minimise the included angle (Θ) between incident light (17) and reflected light (16).

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SURVEILLANCE APPARATUS PARTICULARLY FOR USE IN VIEWING VEHICLE NUMBER-PLATES

This invention relates to surveillance apparatus which is particularly intended for use in viewing vehicle number-plates in covert night-surveillance operations.

The viewing or reading of vehicle number-plates at night in a covert manner has long been a problem. Additional visible illumination is usually unacceptable or unavailable, (except possibly in the form of street lights in some situations) and the traditional infra-red illuminator which operates by filtering the output of an incandescent source, can be seen by many people even when 830nm short-wavelength cut filters are employed. Further, in order to image a front number-plate when the vehicle headlights are switched on, a considerable amount of additional illumination is required if the number plate is to be read clearly or at all.

It is an object of the present invention to provide an apparatus for reading vehicle number-plates, particularly in a covert manner during night-surveillance, in which the above-mentioned problems are overcome or at least reduced.

According to the present invention, there is provided a surveillance apparatus comprising an illuminator for emitting a series of high-energy pulses of light, and a camera operating in synchronism with the illuminator to receive said pulses of light. In covert night-surveillance operations, as in viewing vehicle number-plates, this light is infra-red light outside the range visible to the human eye; in the infra-red (IR) range of the spectrum, light is invisible to the human eye at 940nm or 880nm or possibly 820nm, and light-radiation of these wavelengths can be provided by suitable LED or laser sources.

Preferably, said illuminator comprises an array of light-emitting diodes (LEDs) or a source of laser light, and said camera comprises a shuttered TV camera which will usually be of miniature size.

The illuminator and the (miniature) camera may be combined in a small package, which is attractive to covert surveillance operations, and it is preferred to position the illuminator close to the camera lens so as to minimise the included angle between incident and reflected light.

The use of (invisible) IR light not only avoids detection of the surveillance operation, but also reduces the counter-effect which may be produced by the headlamps of the vehicle being observed, and this effect is further reduced by providing the camera with a bandpass filter and reducing the 'open' period of the camera.

If the TV camera is of the (usual) kind which receives visible light, it is desirable to provide for adjustable back-focus to accommodate the difference between the focal points of the camera lens for visible light and for IR light.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a graph showing (μm) wavelengths of light emitted from a conventional incandescent light source having a filament temperature of about 3000°K,

Figure 2 is a similar graph showing the wavelengths of (I.R.) light emitted from a 940nm illuminator; and,

Figure 3 is a diagramatic view showing apparatus according to the present invention for viewing or reading vehicle number-plates, and illustrating the operation of the apparatus.

Referring firstly to Figures 1 and 2 of the drawings, it will be noted that the light energy transmitted from a source 10 such as the 3000° K bulb (Figure 1) contains a substantial degree of visible light, and some IR light. On the other hand, when LEDs are employed, the light energy is conventionally in the range of about 840 to 1000nm; LEDs suitable for the present invention have a centre wavelength of 940nm or 880nm, with a spectral width of, typically, 50nm (Figure 2).

The apparatus according to the present invention comprises the illuminator or light-energy source 10 which, suitably, has an array of standard 940nm LEDs transmitting IR light which is invisible to the human eye, as indicated above with reference to Figure 2. The array may comprise about 40 to 400 LEDs, depending on the required specification of the apparatus, and one LED which has proved satisfactory is the AEG TSIP5201 having a continuous rating of 100mA.

A camera 12 is employed in conjunction with the LED illuminator, in viewing a car number-plate 13, and has electrical connection 14 with the illuminator. The camera comprises a shuttered TV camera having a CCD sensor which is sensitive to IR light, behind a lens unit 15, and records and/or transmits to a possibly-remote TV monitor (not shown) video signals derived from the illumination of the number-plate by the LED array 11. A 'shuttered' TV camera has an integration time (while picture information is being accumulated) which is shorter than its field period. Shuttering may be achieved electronically or mechanically, or by means of an electro-optical shutter, but it is preferable that the shuttering operation

is silent, as occurs with electronic shuttering. The standard 50 per second, field periods for a (U.K.) TV camera are 20mS, but the camera may be shuttered to 1mS for each field which would result in the camera registering only 1/20 of the total light-energy from a broadband continuous source operating for 20mS. However, when used in conjunction with an LED illuminator which produces energy in high-peak pulses which are synchronized with the camera "open" periods, the camera can receive a comparable amount of energy during each shuttering period. In the present embodiment of the invention, the aforementioned LEDs TSIP5201 have a continuous rating of 100mA, but the driving circuits in the illuminator 10 feed high-energy pulses of about 1000mA, or possibly more, at a rate of 50 pulses per second with each pulse having a duration of 1mS; as a result, the camera receives at least 50% of the energy from broadband illumination without the restriction of shuttering. A rate of 60 pulses per second would be appropriate if, for example, U.S. system TV monitors were to be employed with U.S. system cameras (12).

It is to be noted that the focal point of any lens, for IR light, lies behind the focal point for visible light. In order to achieve sharp focussing when employing a TV camera which also receives visible light, it is desirable to be able to change the back-focus of the camera. The PEARPOINT P176 camera is particularly suitable for use in the apparatus of the present invention, as it incorporates motorised back-focus which facilitates initial set up for each operation; this camera also provides high sensitivity, extended IR sensitivity up to 1100nm, high resolution and a selectable (on/off) shutter.

In operation, therefore, the LEDs emit high energy due to high-peak 1000mA pulses of a duration of about 1mS

in synchronism with the cameras "open" periods of 1mS. This illumination is sufficient for reading car number-plates at night, under normal conditions. The disadvantage which car headlamps can cause is substantially reduced as the level of energy received by the camera from the steady light produced by the headlamps during each period of 1mS, effectively of chopped waveform, is much less than the energy level received during those periods from the high-peak pulses generated by the LEDs.

To reduce even further the effect of car headlamps, a band-pass filter may be introduced into the optical path 16 to the camera; this filter is centered on the peak output wavelength of the LEDs (in the IR band) and has a bandwidth which passes most of the LED energy but rejects light of other wavelengths such as the remaining energy emitted from the broadband vehicle headlamps.

As an alternative to the LED illuminator described, it is possible to employ a source of laser light which, although more expensive than LEDs, would allow a much narrower bandpass filter to be used which could reduce still further the counter-effect of headlamp illumination. When employing laser light, which usually has a wavelength of about 820nm, the possibility of visibility from certain viewpoints cannot be ignored, but the small chance of detection is regarded as an acceptable risk. It should be noted that a person with exceptional eyesight could, in certain circumstances, detect IR light of 880nm or conceivably longer wavelength, but again this is regarded as an acceptable risk.

According to a further feature of the invention, the light energy fed to the camera by the LED pulses can be changed on a field-by-field basis, to provide images of the number-plate which will then appear brighter or dimmer. These images are produced at very short

intervals of time, and may subsequently be selected to facilitate the reading of a number-plate which may be unclear due to poor reflectivity caused by, for example, dirt on the plate. The camera will usually have a fixed iris, and the pulse energy may be changed by varying amplitude or duration, and it is to be noted that reduction of duration, say from 1mS in stages to 0.3mS, has the added advantage of reducing possible blurring caused by movement of the vehicle. Similarly, the camera shuttering time may be changed on a field-by-field basis, to reduce yet further the counter-effect of headlamps.

Vehicle number-plates (12) in many countries including U.K. are of a type which give very high reflectance, provided that the illuminator 10 and camera 12 are very close together. As shown in Figure 3, appropriate arrangement of the illuminator array 11 and the camera lens 15 can reduce below 5° the included angle θ between the incident beam 17 and the reflected beam 16. This narrow angle can result in a reduction in the amount of illumination required.

The apparatus is useful in viewing vehicle number-plates during the dark, and also during dawn and dusk, and may operate continuously to cover daylight hours. It will be appreciated that, for daylight use, and also in non-covert operations such as traffic surveys, the question of visibility may be of little importance and pulsed illuminators in the spectral bands of wavelengths shorter than IR may be employed.

Yet a further advantage of the apparatus of the present invention is that the illuminator and TV camera can be of small size, possibly packaged in the form of a cube having sides of the order of 100mm. The power required for the LED illuminator may be as low as 7 or 8 watts and, operating at 12 volts, permits battery operation.

CLAIMS

1. A surveillance apparatus comprising an illuminator for emitting a series of high-peak power pulses of light, and a camera operating in synchronism with the illuminator to receive the pulses of light after reflection from an object being observed.

2. An apparatus for viewing vehicle number plates in covert night-surveillance operations, comprising an illuminator for emitting a series of high-peak power pulses of infra-red light outside the range visible to the human eye, and a camera operating in synchronism with the illuminator to receive the pulses of infra-red light after reflection from a number plate.

3. An apparatus as claimed in Claim 2, in which said camera is provided with a bandpass filter to reduce counter-effects produced by headlamps of the vehicle being observed.

4. An apparatus as claimed in any preceding Claim, in which said illuminator comprises an array of light-emitting diodes.

5. An apparatus as claimed in Claim 4, in which said array comprises between 40 and 400 940nm light-emitting diodes.

6. An apparatus as claimed in any of Claims 1 to 3, in which said illuminator comprises a source of laser light.

7. An apparatus as claimed in any preceding Claim, in which said camera is a miniature camera, and said illuminator and the miniature camera are combined in a small package.

8. An apparatus as claimed in any preceding claim, in which said illuminator is positioned close to the camera lens so as to minimise the included angle between incident and reflected light.

9. An apparatus as claimed in any preceding Claim, in which said camera comprises a shuttered T.V. camera.

10. An apparatus as claimed in Claim 9, in which means are provided for varying the duration of said high-peak pulses of light, and means are provided for effecting corresponding adjustment of the shuttering of said camera on a field-by-field basis, to control the brightness of images derived from the camera.

11. An apparatus as claimed in any preceding Claim, in which means are provided for varying the intensity of said high-peak power pulses of light, on a field-by-field basis, to control the brightness of images derived from the camera.

12. An apparatus for viewing vehicle number-plates, substantially as hereinbefore described with reference to the accompanying drawings.

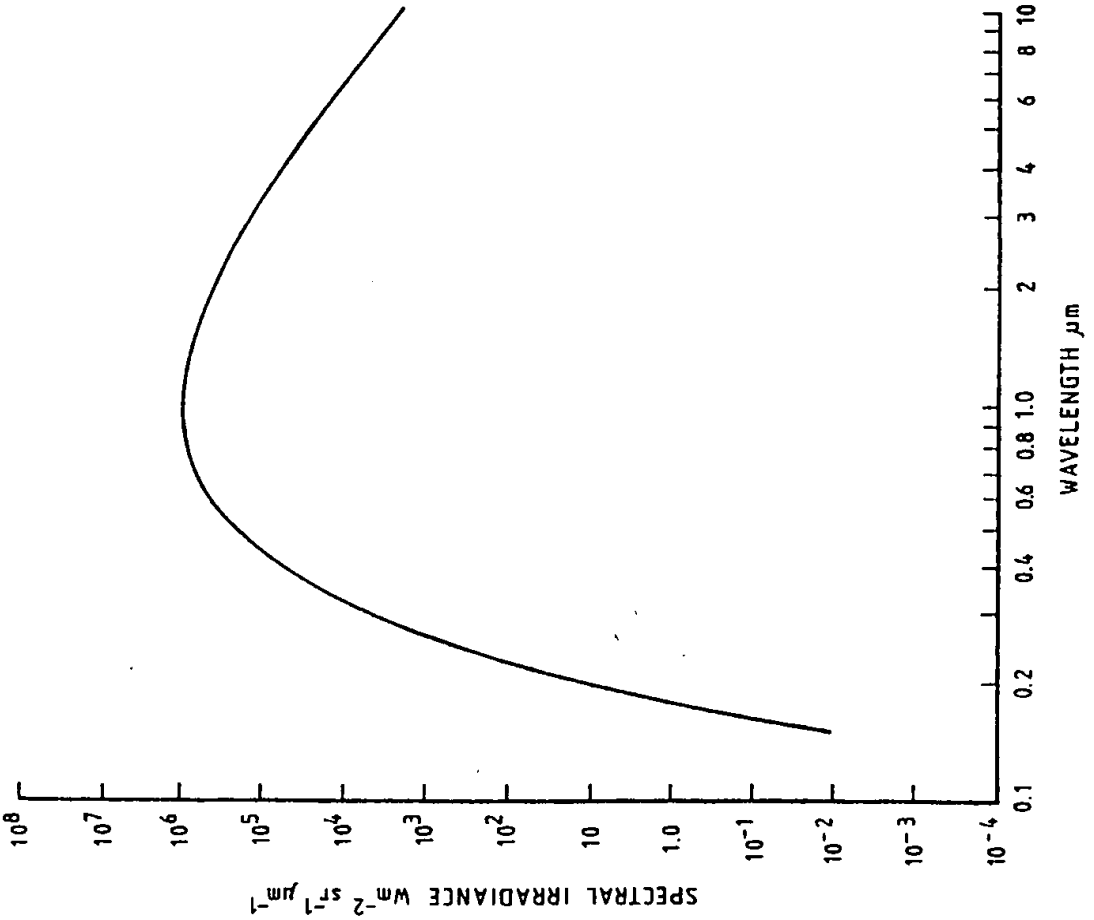
SPECTRAL IRRADIANCE $Wm^{-2}\,sr^{-1}\,\mu m^{-1}$
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10
1.0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
0.1
0.2
0.4
0.6
0.8
1.0
2
3
4
6
8
10
WAVELENGTH μm

FIG. 1

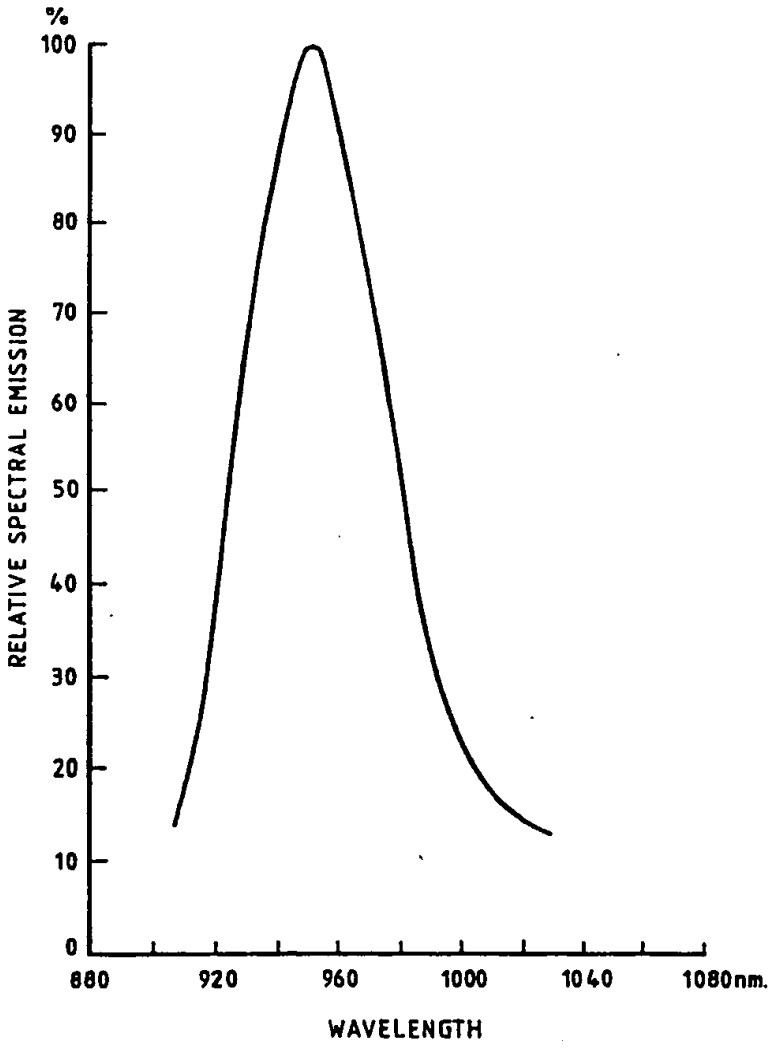
%
100
90
80
70
60
50
40
30
20
10
0
RELATIVE SPECTRAL EMISSION
880
920
960
1000
1040
1080nm.
WAVELENGTH

FIG. 2

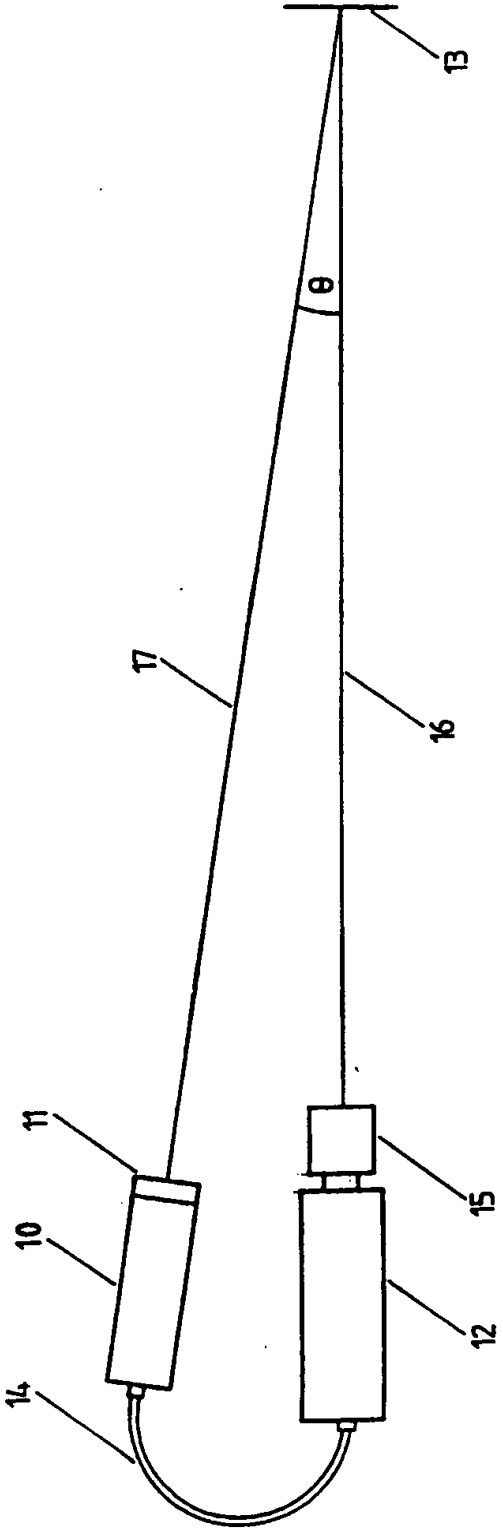

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/01405

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 G08G1/054

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	G08G

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	EP,A,0 104 437 (SODI) 4 April 1984 see page 4, line 17 - page 8, line 12; figures 1-4	1,2,3,12
Y		4-8
A		9-11
Y	GB,A,2 142 738 (SHIRLEY DEVELOPMENTS LTD) 23 January 1985 see page 1, line 29 - line 71	4-8
Y	EP,A,0 178 015 (TELECOMMUNICATIONS RADIOELECTRIQUES ET TELEPHONIQUES T.R.T.) 16 April 1986 see abstract	6

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
30 OCTOBER 1991	19. 11. 91
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	CRECHET P.G.

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ANNEX TO THE INTERNATIONAL SEARCH REPORT
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0104437	04-04-84	None	
GB-A-2142738	23-01-85	JP-A- 60069563	20-04-85
EP-A-0178015	16-04-86	FR-A- 2571506	11-04-86
		DE-A- 3562680	16-06-88
		US-A- 4642452	10-02-87

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